UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION DIVISION
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OFFICE OF
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: Olin Chemical Superfund Site (Wilmington MA) (19-R01-001)

FROM: Scott G. Huling, Environmental Engineer
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TO: James DiLorenzo, Remedial Project Manager
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A preliminary technical review has been completed regarding the removal of dense aqueous phase liquids (DAPL) at the Olin Chemical Superfund Site. Various documents were reviewed including the 2 Power Point presentations used at the 2016 and 2017 NARPM conferences, Response Alternatives Evaluation Report, Olin Chemical Superfund Site (51 Eames Street, Wilmington MA), the DAPL overview data figure 2018-10-31.pdf, and the Olin site ORD Presentation_Nov 14 2018 (004).pptx. Comments and recommendations are included below regarding a proposed explanation for the “failure” of the DAPL removal pilot test, and a potential alternative design involving a short-screened extraction well to remove the DAPL. The objective of the alternative well design is to allow multiple wells to operate simultaneously, minimize disturbance of the DAPL, achieve a uniform decline in the DAPL pool, and to optimize/shorten the time of recovery of the DAPL groundwater. Dr. Klara Rusevova (National Research Council, Ada, OK) assisted in this technical review. If there are questions, or if additional assistance can be provided, please call me (580) 436-8610.

cc: Lynne Jennings, Region 1
Bill Brandon, Region 1
Jan Szaro, Region 1
James Cummings HQ
Ed Gilbert, HQ
David Bartenfelder, HQ
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Technical Review Comments and Recommendations.

Specific Comments.

1. *Background Information.* Several slides (17, 20, 23-24) in the Power Point presentation (Olin site ORD Presentation Nov 14 2018 (004).pptx) provides useful information that helps to explain a potential cause for the "failure" of the DAPL removal pilot test. Information in these slides are also key in the development of alternative extraction well design guidelines that may potentially improve the probability of "successful" DAPL removal. Note, in slide 24, it is unclear to what extent the scale is accurate in the figure. However, it is assumed that the concepts presented are accurate.

a. There is minimal water table drawdown in EW-1 during the pilot test pumping period (slide 24), but there is significant "drawdown" of the DAPL layer. This observation suggests there are separate effects from pumping on the overlying groundwater and the DAPL, i.e., drawdown of the water table versus the "disturbance" of the DAPL layer.

b. It is proposed that the integrity of the DAPL to exist as a separate aqueous phase is sensitive to the transport of the overlying groundwater into the extraction well during pumping, i.e., shear-produced turbulence either from horizontal or vertical movement of the pumped groundwater. The multi-level groundwater monitoring well, ML-1 (slide 20) located 20 ft away, indicated that the disturbance of the DAPL occurred almost immediately after pumping started. The interval that did not significantly respond to pumping was port 6 which was not representative of the DAPL (conductivity < 20,600 μmhos/cm).

c. A summary of the construction and elevation details of EW-1 (slide 17) are provided below to put these elevations in context with the DAPL interface. These elevations use "BMP" as the vertical datum.

- the top of the well seal is 29.8 ft bmp
- the top of the sand pack is 37.25 ft bmp
- the top of the well screen is 40.9 ft bmp
- the base of screen is 45.32 ft bmp
- the top of bedrock is 45.5 ft bmp
- the bottom of the sump is 48.2 ft bmp

2. *Cause and Effect.* There was approximately 7 ft of DAPL to start the pilot test and 1.7 ft was drawn down or "disturbed" over the course of the test (slide 23). The basis for the measurement of 7 ft of DAPL in EW-1 was unclear. Assuming the measurement included the top of the >20,600 μmhos/cm level to the bottom of the sump in EW-1, then at the beginning of the pilot test, the DAPL "interface" was at 41.2 ft bmp. This places the DAPL interface within the 5 ft well screen. Assuming the measurement included the top of the >20,600 μmhos/cm level to the top of the bedrock depth, then at the beginning of the pilot test, the DAPL interface was at 38.4 ft bmp, which is within the sand pack and close to the well screen. In either case, when the EW-1 well was pumped, it appears that water and DAPL were both drawn into the well screen. It is proposed that when overlying groundwater is moving horizontally across the top of DAPL,

and/or vertically through the DAPL, this results in shear-produced turbulence causing the disturbance of the DAPL layer and consequently the mixing of the two layers. The immediate decline in conductivity in ML-1 support this general observation and provides a viable explanation why the pilot test “failed”.

3. *Alternative Extraction Well Design.* The following well construction guidelines are recommended to limit the potential for “failure”. Specifically, the well is designed to maximize the distance between (1) the DAPL intake of the extraction well, and (2) the “interface” between the DAPL and the overlying groundwater. To accomplish this, it is recommended that the extraction well be constructed with a 1 ft well screen, and a sand pack that extends 1 ft above the well screen. The bentonite well seal overlying the sand pack could be constructed in a similar manner as EW-1. The bottom of the well screen would be placed at the top of the bedrock, with a sump built into the bedrock as in EW-1. Assuming the 1 ft well screen is constructed using 0.01 inch slotted screen (schedule 40 PVC) as EW-1, the entrance velocities for 0.5, 1.0, and 2.0 gpm are 2.59×10^{-2}, 5.18×10^{-2}, and 1.04×10^{-1} ft/s. These entrance velocities are well below the 1.5 ft/s standard entrance velocity recommended for groundwater production wells.

Assuming the recommended extraction well design guidelines are acceptable for DAPL removal, it is recommended to construct one test well using these guidelines, and to conduct a pilot test similar to the previous pilot test to assess whether “failure” can be avoided. Assuming the test results are satisfactory, it is recommended to construct several wells in each DAPL area that are spaced in a manner that minimizes the hydraulic impact between wells. It is also recommended to install the wells in locations where the depth to bedrock is at a maximum, if possible. For example, in the aquifer cross section conceptualization (slide 24), it appears the location of EW-1 is at an elevation above the “bottom of the bowl”, at least conceptually. Placing the extraction wells at locations where the vertical depth to bedrock is maximum helps to assure greater separation between the inlet to the extraction well within the DAPL zone, and the DAPL “interface”. Further, this helps to assure the maximum DAPL volume recovery since the well has access to the lowest elevation within the DAPL pool. The overall objective of these recommendations is to allow multiple wells to operate simultaneously, to minimize disturbance of the DAPL, to achieve a uniform decline in the DAPL pools, and to optimize the time of recovery of the DAPL groundwater.

4. *Contrast vertical and horizontal wells.* At this point it is unclear whether the proposed alternate short-screen well design described here, or horizontal wells would be more feasible for DAPL recovery. A preliminary assessment is provided here to serve as a starting point for a more detailed comparison needed to fully identify the technical merits of each. It is assumed in this preliminary analysis that a key element in the design of a DAPL extraction system is to place the point of extraction at the top of bedrock. Horizontal wells, if installed at the surface of the bedrock, may effectively provide significant perforated pipe drainage over a large area that would likely accommodate high flow to effectively remove DAPL, while minimizing mixing between the overlying groundwater and the DAPL interface. However, in general there appears to be uncertainty associated with the bedrock surface attributed to the undulating nature of the bedrock topography. Consequently, there may be a limitation in the installation of horizontal well at the base of the bedrock surface. This may also lead to unintentional mixing of groundwater and DAPL if the horizontal well changes elevation relative to the DAPL layer. The

short-screen extraction well design would likely involve similar construction methods already deployed at the site for EW-1. Using these conventional drilling methods, the bottom of the well screen could be placed in close proximity to the bedrock surface at each location, as achieved with EW-1. Installation of wells could be strategically located relative to bedrock topography and the pumping rate of the wells could be operated independently based on water quality performance needs. However, sufficient wells would need to be installed and operated at a rate required to optimize DAPL recovery to achieve remedial goals within an acceptable timeframe. Overall, a more detailed evaluation of the technical merits of these DAPL extraction options, and possibly others, is needed.